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ABBREVIATIONS

Abbreviation	Full Form
AADT	Annual Average Daily Traffic
AAQ	Ambient Air Quality
AASHTO	American Association of State Highway and Transportation Officials
ADB	Asian Development Bank
ADT	Average Daily Traffic
AIL	Aggregate Interlayer
ASI	Archaeological Survey of India
ATCC	Automatic Traffic Counter and Classifier
ATMS	Advanced Traffic Management System
AUP	Animal Underpass
BA	Borrow Area
BC	Bituminous Concrete
BIS	Bureau of Indian Standards
BOCW Act	Building & Other Construction Workers Act
BOQ	Bill of Quantity
BOT	Build Operate Transfer
C/w	Carriageway
CA	Concession Agreement
CAD	Computer Aided Design
CAGR	Cumulative Annual Growth Rate
CALA	Competent Authority Land Acquisition
CAPEX	Capital Expenditure
CB	Crash Barrier
CBR	California Bearing Ratio
CD	Cross-Drainage
CD	Consolidated Drained
CFD	Cumulative Fatigue Damage
CFI	Consolidated Fund of India
CGT	Capital Gains Tax
CMU	Corridor Management Unit
CoD	Cut-off Date
CPCB	Central Pollution Control Board
CR	Cost Ratio
CRCP	Continuously Reinforced Concrete Pavement
CRZ	Coastal Regulation Zone
CSA	Cumulative Standard Axle
CTB	Cement Treated Base

Abbreviation	Full Form
CTSB	Cement Treated Sub-base
CTVC	Classified Traffic Volume Count
CUP	Cattle Underpass
CVPD	Commercial Vehicles Per Day
CWC	Central Water Commission
CWLW	Chief Wild Life Warden
CZMP	Coastal Zone Management Plan
DBM	Dense Bituminous Macadam
DCF	Discounted Cash Flow
DEM	Digital Elevation Model
DFO	Divisional Forest Officer / Deputy Conservator of Forest
DGPS	Differential Global Positioning System
DL	Dead Load
DLC	Dry Lean Concrete
DLC	District Level Committee
DM	District Magistrate
DM	Divisional Magistrate
DPR	Detailed Project Report
DS	Disturbed Sampling
DTM	Digital Terrain Model
EAC	Expert Appraisal Committee
EC	Economic Corridor
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EIRR	Equity Internal Rate of Return
EMP	Environmental Management Plan
ENPV	Economic Net Present Value
EPC	Engineering Procurement & Construction
ESA	Equivalent Standard Axles
ESAL	Equivalent Single Axle Load
ETC	Electronic Toll Collection
FCFE	Free Cash Flow to Equity
FIPL	Feedback Infra Private Limited
FO	Flyover
FOS	Factor of Safety
FR	Feeder Route
FRL	Finished Road Level
FY	Financial Year
GAD	General Arrangement Drawing
GC	Generalized Cost
GDP	Gross Domestic Product
GL	Ground Level

Abbreviation	Full Form
GoI	Government of India
GPS	Global Positioning System
GQ	Golden Quadrilateral
GR	Growth Rate
GRC	Grievance Redressal Committee
GSB	Granular Sub-base
GSDP	Gross State Domestic Product
GST	Goods and Services Tax
GTS	Great Trigonometrical Survey
GW	Ground Water
HAM	Hybrid Annuity Model
HDI	Human Development Index
HDM	Highway Development and Management
HFL	High Flood Level
HPDE	High Density Polyethylene
HS	Highway Service
HYSD	High Yield Strength Deformed
IC	Inter-Corridor
IDC	Interest During Construction
IL	Intermediate Lane
IMD	India Meteorological Department
IMU	Inertial Measurement Unit
INR	Indian Rupee
IRC	Indian Road Congress
IRR	Internal Rate of Return
IS	Indian Standard
ISA	Initial Social Assessment
ISD	Intermediate Sight Distance
IT	Information Technology
JBIC	Japan Bank for International Cooperation
kmph	Kilometre Per Hour
kmph	Kilometer Per Hour
LA	Land Acquisition
LAP	Land Acquisition Plan
LCV	Light Commercial Vehicle
LHS	Left Hand Side
LL	Liquid Limit
LMV	Light Motor Vehicle
LOS	Level of Service
LS	Lump Sum
LSD	Limit State Design
LVUP	Light Vehicular Underpass

Abbreviation	Full Form
LWL	Lowest Water Level
MAV	Multi Axle Vehicle
MCLR	Marginal Cost of Lending Rate
MDD	Maximum Dry Density
MDR	Major District Road
MIDAS	Marine Information and Data Acquisition System
MJB	Major Bridge
MNB	Minor Bridge
MoEF&CC	Ministry of Environment, Forest and Climate Change
MoRT&H	Ministry of Road Transport and Highways
MPa	Megapascal Pressure
MR	Major Road
MSA	Million Standard Axle
MSL	Mean Sea Level
MSME	Micro, Small and Medium Enterprises
MT	Metric Ton
NBWL	National Board for Wildlife
NGO	Non-Governmental Organisation
NH	National Highway
NHAI	National Highways Authority of India
NHDP	National Highways Development Project
NOC	No Objection Certificate
NPV	Net Present Value
NRSC	National Remote Sensing Centre
NSDP	Net State Domestic Product
NS-EW	North South - East West
O&M	Operation and Maintenance
OD	Origin - Destination
ODR	Other District Road
OFC	Optical Fibre Cable
OHT	Overhead Tanks
OMC	Optimum Moisture Content
ORR	Outer Ring Road
OSMEFWC	Online Submission & Monitoring of Environmental, Forests and Wild Life Clearance
PAP	Project Affected People
PBFF	Permanent Bridge Fee Fund
PCC	Plain Cement Concrete
PCCF	Principal Chief Conservator of Forests
PCI	Per Capita Income
PCU	Passenger Car Unit
PD	Project Director

Abbreviation	Full Form
PI	Plasticity Index
PIA	Project Influence Area
PIRR	Project Internal Rate of Return
PIU	Project Implementation Unit
PL	Plastic Limit
PPP	Public Private Partnership
PQC	Pavement Quality Concrete
PROW	Proposed Right of Way
PS	Paved Shoulder
PSC	Pre Stressed Concrete
PTFE	Poly Tetra Fluoro Ethylene
PUC	Pollution Under Control
PUP	Pedestrian Underpass
PV	Present Value
PWD	Public Works Department
R&R	Rehabilitation and Resettlement
RAP	Resettlement Action Plan
RCC	Reinforced Cement Concrete
RE Wall	Reinforced Earth Wall
RF	Reserve Forest
RFCTLARR Act	The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act
RFO	Reserve Forest Officer
RFP	Request for Proposal
RHS	Right Hand Side
RO	Regional Office
ROB	Rail Over Bridge
RoW	Right of Way
RQD	Rock Quality Designations
SAIL	Steel Authority of India Limited
SBWL	State Board for Wildlife
SC	Schedule Caste
SDM	Sub-Divisional Magistrate
SEIAA	State Environment Impact Assessment Authority
SEZ	Special Economic Zone
SH	State Highway
SIDL	Superimposed Dead Load
SIPCOT	State Industries Promotion Corporation of Tamil Nadu Ltd.
SLS	Serviceability Limit State
SOI	Survey of India
SoR	Schedule of Rates
SP	Special Publication

Abbreviation	Full Form
SPCB	State Pollution Control Board
SPT	Standard Penetration Test
SR	State Road
ST	Schedule Tribe
SUH	Synthetic Unit Hydrograph
SV	Special Vehicle
SVUP	Small Vehicle Underpass
SW	Surface Water
TANSIDCO	Tamil Nadu Small Industries Development Corporation Ltd.
TCS	Typical Cross section
TIDCO	Tamil Nadu Industrial Development Corporation Ltd.
TIIC	Tamil Nadu Industrial Investment Corporation Ltd.
TL	Trip Length
TN	Tamil Nadu
TOR	Terms of Reference
TP	Toll Plaza
TPS	Thermal Power Station
TR	Toll Rates
TT	Travel Time
UDS	Undisturbed Sampling
ULS	Ultimate Limit State
UNESCO	United Nations Educational, Scientific and Cultural Organization
VDF	Vehicle Damage Factor
VG	Viscosity Grade
VGF	Viability Gap Funding
VIDS	Video Incident Detection System
VOC	Vehicle Operating Cost
VOP	Vehicular Overpass
VOT	Value of Time
VR	Village Road
VUP	Vehicular Underpass
WACC	Weighted Average Cost of Capital
WB	World Bank
WC	Wearing Course
WGS	World Geodetic System
WIM	Weigh in Motion
WLS	Wild Life Sanctuary
WMM	Wet Mix Macadam

0 EXECUTIVE SUMMARY

0.1 General

Ministry of Road Transport & Highways (MoRTH) intends to take up the "Consultancy Services for preparation of Feasibility Study and Detailed Project Report for Construction of 2 lane/2 lane with paved shoulder from Kohima to Nagaland/Manipur border section of NH-29 (Old NH-150) in the State of Nagaland under SARDP Phase-B on EPC Mode".

The Ministry of Road Transport & Highways (MoRTH) appointed **M/s. Feedback Infra Pvt. Ltd. (FIPL)** for providing the required "Consultancy services for Preparation of Feasibility Study and Detailed Project Report for Construction of 2 lane/2 lane with paved shoulder from Kohima to Nagaland/Manipur border section of NH-29 (Old NH-150) in the State of Nagaland under SARDP Phase-B on EPC Mode". The Contract Agreement for the assignment was signed on 12th May 2015 and through letter NH-12011/12/2014/NG/SARDP-NE dated 27th May, 2015 consultants were instructed to commence the Assignment and the project activities thereafter.

The project has been included under Bharatmala Pariyojan for their Improvement / development by National Highways and Infrastructure Development Corporation limited (NHIDCL), through vide letter no.NH-12037/27/2018/Bharatmala/SARDP-NE/Zone-V, dated 28th September, 2018.

0.2 Project Background

The project highway starts from Km 3.000 of NH- 29 (old NH-150) and ends at Km 132.000 of NH-29 (old NH-150) near Jessami in Manipur State. The end point of the road also intersects on NH-202 (old NH-155). The existing length of the project road is Km 132.000.

After the discussion with CE (NER)- MORTH, it was decided to obsolete from Km 3.000 to Km 7.880 of the project reach. This was deleted because it was already awarded to other consultant for DPR preparation. Hence the start of the project road is from Km 7.880 of NH- 29 (old NH-150) and end point remains the same. Now the length of project road is 124.120 Kms.

The Project Highway passes through districts Kohima and Phek in the state of Nagaland and Ukhrul in the state of Manipur. It connects important Town / Villages namely Kohima, Chakabama, Kiruma, Fpsutsero, Misulumi, Enhulum, Chizami, Losami, Laniye and Jessami.

The existing length of the Project Highway is about 124.120 kms while the design length of the project road is 121.090 kms (Ch. 7.880 to Ch. 128.970). There is no requirement of bypassing any town/ village along the entire project Highway. The entire project road is divided into six packages and the details are given in table below;

The key plan of the project highway is shown in figure below;

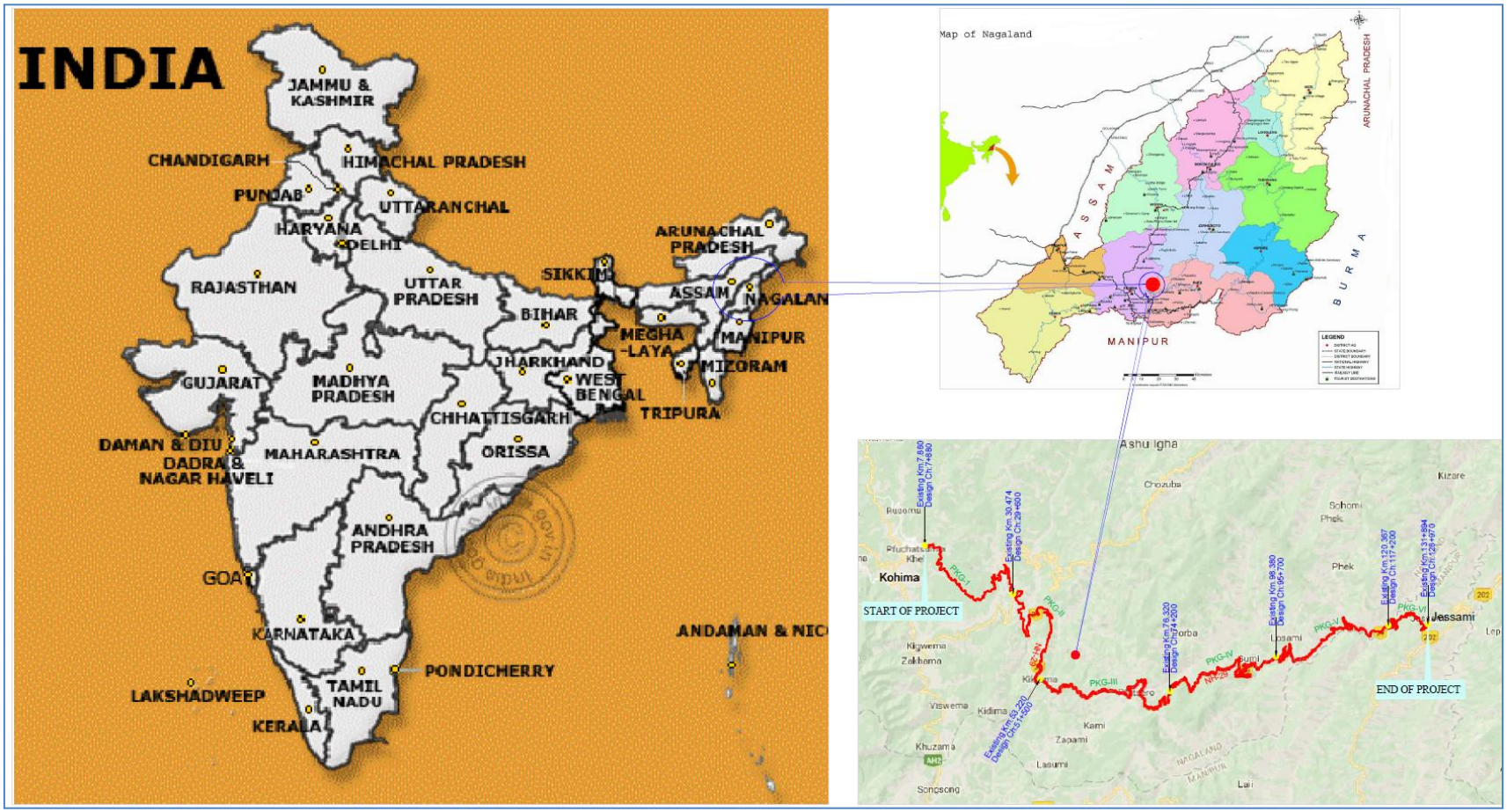

Figure 0-1 Key Plan of the Project Highway

0.3 Project Road

Existing Project Highway, part of NH-29 (old NH-150) starts near existing km 7.880 at Chedama Road in Kohima (Nagaland) and terminates near existing km 131.894 at its junction with NH-202 (old NH-155) near Jessami in Manipur state.

0.4 Construction Packages

The entire project highwat is divided into six construction packages and the details are given in table below;

Table 0-1 Details of the Construction Packages

Package No	Existing Location (Km)		Design Chainage (Ch.)		Total Length (Km)		Name of nearest Town/ Village	
	From	To	From	To	Existing	Design	From	To
I	7.880	30.474	7+880	29+600	27.474	21.72	Chedama Road junction	Near Junction of Kigwema Road, Chakabama
II	**30.474**	**53.22**	**29+600**	**51+500**	**22.746**	**21.9**	**Near Junction of Kigwema Road, Chakabama**	**Near Kikruma Village**
III	53.22	76.32	51+500	74+200	23.1	22.7	Near Kikruma Village	Near Mesulumi Village
IV	76.32	98.38	74+200	95+700	22.06	21.5	Near Mesulumi Village	Near Chizami
V	98.38	120.37	95+700	117+200	21.987	21.5	Near Chizami	Nagaland/ Manipur Border
VI	120.37	131.89	117+200	128+970	11.527	11.77	Nagaland/ Manipur Border	At junction of NH-29 (Old NH-150) with NH-202 (Old NH-155) near Jessami Village in Manipur State

As per ToR all the DPR submissions are to be submitted as construction package-wise, therefore from here onwards “The Project Highway” referred shall be confined to the section of that particular construction package only.

Therefore, this Final Detailed Project Report pertains to "Construction of 2 lane/ 2 lane with paved shoulder from Chedama Road in Kohima to Junction of Kigwema Road, Chakabama in Nagaland State section of NH-29 from existing km 30.474 (Design Ch. 30+000) to km 53.220 (Design Ch. 51+500) - Construction Package – II" only.

0.5 Salient features of the project road

The project highway mostly passes through hilly and mountainous terrain. The cross slope of the project highway varies 14 degree to 31 degrees. The existing geometry of the carriageway is deficient at most of the locations.

- The entire Project Highway passes through hilly Terrain.
- The existing alignment comprises of many sharp horizontal and deficient vertical curves which require geometric corrections.
- The land use patterns along the Project Highway can be categorized as Agricultural, Barren and Urban/Built-up.
- The existing carriageway of the Project Highway has predominantly single lane carriageway with earthen shoulder configuration except few locations where it has intermediate lane and 2-Lane with earthen shoulder carriageway configuration.
- The existing pavement of the Project Highway is bituminous but in many locations bituminous layers are either has been washed out or in fair to poor condition.
- The width of earthen shoulder varies from 0.5 m to 2.0 m on both sides, and condition of the earthen shoulders is poor to very poor.

0.6 Topographic Survey

Topographical survey is important to generate the drawing and to give the overall existing features of the ground. The Topographical survey has been carried out along the project alignment to provide the information in 3D. The topo survey was carried out by using DGPS / Total station method.

0.6.1 The width of survey corridor will generally be as given under:

i. The width of the survey corridor considered the layout of the proposed alignment including the extent of embankment and cut slopes and the general ground profile. While carrying out the field surveys, the widening scheme (i.e. right, left or symmetrical to the centreline of the existing carriageway) were taken into consideration so that the topographic surveys covers sufficient width beyond the centreline of the proposed divided carriageway. The surveys covered a minimum of 55 m beyond either side of the centreline of the proposed divided carriageway or land boundary whichever was more.
ii. Where existing roads crosses the alignments, the survey was extended to 25m either side of the road centreline and will be of sufficient width to allow improvements, including at grade intersection to be designed.

0.6.2 Longitudinal and Cross-Sections

The topographic surveys for longitudinal and cross-sections covered the following:

i. Longitudinal section levels along final centreline at every 1 m interval, at the locations of curve points, small streams, and intersections and at the locations of change in elevation.
ii. Cross sections at every 1 m interval in full extent of survey covering sufficient number of spot levels on existing carriageway and adjacent ground for profile correction course and earth work calculations. Cross sections were taken at closer interval at curves.
iii. Longitudinal section for cross roads for length adequate for design and quantity estimation purposes.
iv. Longitudinal and cross sections for major and minor streams which cover Cross section of the channel at the site of proposed crossing and few cross sections at suitable distance both upstream and downstream, bed level upto top of banks and ground levels to a sufficient distance beyond the edges of channel, nature of existing surface soil in bed, banks & approaches, longitudinal section of channel showing site of bridge etc.

0.7 Traffic Surveys and Demand Forecast

The Project Highway passes through mountainous and steep terrain. Based on physical characteristics and major junctions within the stretch and considering the traffic generation/diversion points, the project highway is divided into three homogeneous sections for the purpose of analysis and presentation of traffic and travel characteristics. The details of the homogeneous sections defined for the study are given in table below;

Table 0-2: Homogeneous traffic sections

Section No.	Starting		Ending		Length (in km)
	Existing km	Place	Existing km	Place	
I	km 7.880	End of Kohima Bypass	km 30.600	Chakhabama	22.720
II	km 30.600	Chakhabama	km 68.000	Pfutsero	37.400
III	km 68.000	Pfutsero	km 131.894	Jessami	63.894

Traffic volume count data for 7 days at each location was averaged to determine Average Daily Traffic (ADT). The location wise ADT by vehicle type is given in table below;

Table 0-3: Average Daily Traffic at count locations

Vehicle Type	Chidema	Pfutsero	Losami
	km 13.000	Km 64.500	km 107.000
Car / Jeep / Van (Private)	173	129	106
Car / Jeep (Taxi)	0	0	0
Shared Jeep	0	0	0
Mini Bus	0	0	0
School. Bus	0	0	0
Govt. Bus	9	9	7
Pvt. Bus	0	0	0
Maxx/Pick-Up	0	0	0

Vehicle Type	Chidema	Pfutsero	Losami
	km 13.000	**Km 64.500**	**km 107.000**
LCV (4 tyre)	0	0	0
LCV	25	30	27
2 Axle trucks	31	40	26
3 Axle trucks	0	0	0
MAV (4 to 6 Axles)	0	0	0
MAV (> 6 Axles)	0	0	0
Others	0	0	0
3 Wheeler	0	0	0
2 Wheeler	33	32	28
Agriculture Tractor	0	0	0
Agriculture Tractor with Trailer	0	0	0
Cycle	0	0	0
Cycle Rickshaw	0	0	0
Animal Drawn Cart	0	0	0
Grand Total (Nos.)	**271**	**240**	**194**
Grand Total (PCUs)	**347**	**337**	**260**

Summary of AADT vehicle type wise at various locations along the project highway is given in table below;

Table 0-4: Annual Average Daily Traffic at Count Locations

Vehicle Type	Chidema	Pfutsero	Losami
	km 13.000	**Km 64.500**	**km 107.000**
Car / Jeep / Van (Private)	173	129	106
Car / Jeep (Taxi)	0	0	0
Shared Jeep	0	0	0
Mini Bus	0	0	0
School. Bus	0	0	0
Govt. Bus	9	9	7
Pvt. Bus	0	0	0
Maxx/Pick-Up	0	0	0
LCV (4 tyre)	0	0	0
LCV	25	30	27
2 Axle trucks	31	40	26
3 Axle trucks	0	0	0
MAV (4 to 6 Axles)	0	0	0
MAV (> 6 Axles)	0	0	0
Others	0	0	0
3 Wheeler	0	0	0
2 Wheeler	33	32	28

Vehicle Type	Chidema	Pfutsero	Losami
	km 13.000	**Km 64.500**	**km 107.000**
Agriculture Tractor	0	0	0
Agriculture Tractor with Trailer	0	0	0
Cycle	0	0	0
Cycle Rickshaw	0	0	0
Animal Drawn Cart	0	0	0
Grand Total (Nos.)	**271**	**240**	**194**
Grand Total (PCUs)	**347**	**337**	**260**

The summary of observed ADT and AADT along the project road is given below;

Table 0-5: Summary of ADT and AADT at count locations

Location	ADT		AADT	
	Nos.	PCUs	Nos.	PCUs
km 13.000	271	347	271	347
Km 64.500	240	337	240	337
km 107.000	194	260	194	260

The Estimated Growth rates arrived based on multiplying Elasticity values and growth in Economic factors. The recommended growth rates are given in table below;

Table 0-6: Estimated and Recommended Traffic Growth Rates

Vehicle type	2017-21	2022-26	2027-31	Beyond 2031
Most likely Scenario				
Car	4.40	3.97	3.58	3.23
Two Wheelers	5.76	5.20	4.69	4.23
Bus	4.84	4.37	3.94	3.56
LCV	11.72	10.20	9.12	8.20
2AT	6.62	5.80	4.96	4.16
3Axle	5.0	5.0	5.0	5.0
MAV	5.0	5.0	5.0	5.0

0.7.1 Projected Total (Normal + Generated) Traffic

The summary of projected traffic along the project road is given in table below;

Table 0-7: Projected Total Traffic AADT (Vehicles & PCU)

Year	Km 13.000_Chidema		Km 64.500_Pfutsero		Km 107.000_Losami	
	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU
2015 - 16	271	347	240	337	194	260
2018 - 19	319	412	285	405	231	312
2020 - 21	439	551	404	546	343	442

Year	Km 13.000_Chidema		Km 64.500_Pfutsero		Km 107.000_Losami	
	Vehicles	**PCU**	**Vehicles**	**PCU**	**Vehicles**	**PCU**
2025 - 26	563	718	525	722	446	584
2030 - 31	709	917	671	934	570	757
2035 - 36	879	1149	842	1183	716	961
2040 - 41	1092	1443	1060	1503	904	1227
2045 - 46	1369	1830	1349	1929	1153	1582
2050 - 51	1733	2344	1736	2501	1488	2063

Capacity and design service volumes for various lane configurations are specified in IRC: 64 – 1990, 'Capacity of Roads in Rural Areas', IRC-SP: 73-2015 'Manual of Specifications and Standards for Two-laning of Highways with paved shoulders'. The project highway passes through hill terrain predominantly. The design service volume standards for LoS B and LoS C considered as per guidelines are given in table below;

Table 0-8: Design service volume standards

Road	Shoulder Type	Plain Terrain	Rolling Terrain	Hilly Terrain
Single Lane	Earthen shoulders	2000	1800	1600
Intermediate lane	Earthen shoulders	6000	5700	5200
2 Lane	Earthen shoulders	15000	11000	7000
	Paved shoulders	18000	13000	9000

The traffic projections on the project highway do not demand for the 2-laning in the near future. But Ministry vide Circular no NH-14019/6/2012-P&M dated 5th October, 2012 had decided that, henceforth, whenever new projects of widening/bypass/realignment are taken up, the width of the carriageway shall be at least two lane with paved shoulders irrespective of the traffic thereon.

Later vide circular no NH-15017 / 28 / 2018 - P&M dated 23rd March 2018, it was revised that the carriageway width shall be of intermediate lane configurations, i.e. of 5.5m width (18 ft), with two-lane structures (23 ft.) for traffic volumes ranging from 3,000 PCUs/ day to about 8,000/ day in Hilly and Mountainous terrains.

However, as per the Cl.4.2.3 as given in the Minutes of the Meeting vide letter no. NHIDCL/Nagaland/General/2018/6/9 dated 23rd October 2018, it was recommended that the project road should be designed for 2 lane with hard shoulder configuration for cost optimization.

Thus, the project highway is proposed to be made 2-lane with hard shoulders on EPC mode.

0.8 Subgrade and Material Investigations

0.8.1 Existing Pavement Composition

Broad variation in pavement thickness was observed along the project road. However, the pavement composition of the existing pavement is generally same as bituminous, Base and Sub-base. The wearing coat (Bituminous) varies from 61 mm to 120 mm and at km7+985 top

bituminious layer is washed away and having poor condition, base course varies from 75 mm to 175 mm and Subbase course varies from 185 mm to 300 mm. The bituminous course consists of one layer and appears to be fair to poor in condition. The base course material was moderately strong and dry in general. The sub-grade below the base course was observed to be fine grained clay and silty soil at some locations.

0.8.2 Exisitng Sub-grade

From the lab results, it is observed that the Liquid Limit varies from 30.2 to 34.3, Plastic Limit varies from 20.22 to 24.16 and Plasticity index varies from 6.04 to 13.98. The existing sub-grade CBR results show that the average value is 4.29%, Maximum value is 4.81% and the minimum is 3.93%.

0.8.3 Borrow Area Soil

Soil for construction of embankment fill and sub-grade is available in sufficient quantities from the land adjacent to the road and certain prominent potential extraction areas, which have been identified. These are at Km 1+400, Km 6+650, Km 12+060, 17+650, 24+335, 27+240, and 32+030 etc along the project road. This soil is mainly available from cultivated Lands and Hillock lands.

The test results indicate that the soils in the potential borrow areas fall in CL, CI, SC, SM and SC-ML classes and visualy can be identified as Yellowish, Clayey Silt with Some Shale Pieces / Silt Stone / Clay Stone mixed. Their CBR values ranges from 3.74 to 6.9.

0.8.4 Aggregate Sources

The Nagaland state has huge sources of unutilized & unexploited Natural Minerals. Vast deposits of stone are found in Chakabama, Pfutsero and Jessami which is used as construction materials. The summary of Identified Quarry/Crusher Locations is Chakabama at Km 36.000, Pfutsero near Km 65.000 and Jessami at Km 121.000.

Manufactured materials cement, structural steel and bitumen conforming to the relevant IS codes and complying with the provisions made in the specifications of MORTH are available in Kohima, Dimapur of Nagaland state.

0.9 Highway Improvement Proposals

The horizontal alignment of the corridor has been designed for a speed of maximum 60 kmph and minimum of 30kmph except at hair pin bends where design speed is 20kmph. The recommended minimum Right of Way is 24m in rural and 20m in Urban area. The corridor is fixed based on existing alignment, by minimum disturbance to habitation and efforts has been made, during design of horizontal alignment to keep it as fluent (higher radius) as possible. Vertical gradient has been improved to an extent avoiding to much of cutting and filling. Extra widening is proposed for the curve lesser than 300m. Super elevation is restricted to 7%. Hairpin bend are improved as per the site condition. Parapet wall are provided on valley side where the embankment height is more than 2 m and W-beam crash barrier are provided where the embankment height is less than equal to 3m. 1.5m height Breast wall is provided

where cutting is more than 1.5m and less than 13 m. 3m height breast wall is provided where cutting is more than 3m. Delineators, reflectors and cautionary, mandatory and informatory signages are provided along the project highway to ensure the safety for the road users. Cross-section has been developed on the basis of IRC-73: 2015. 7 / 7.5 m carriageway having lane width of 3.5m has been provided. The hard shoulder width of 0.9 m on both sides is provided. The earthen shoulder of 1m on valley side has been provided at locations where normal embankments slope are provided. Drain has been provided on hill side and parapet wall/ W- beam crash barrier are provided on valley side along with retaining wall.

0.9.1 Highway Proposals

Design proposals for a highway essentially consist of two components, geometric of road and structural composition. Geometric improvement deals with visible dimensions of roadway and is dictated by the traffic and economic considerations. Geometric design involves several design elements such as horizontal and vertical alignments, sight distance considerations, cross sectional elements, lateral and vertical clearances, intersection treatment etc. The structural component deals with the pavement and embankment design aspects, i.e., the ability of the highway to adequately carry and support the vehicle/ wheel loads over the design period.

0.9.2 Cross Sectional Elements

Lanes Section: Cross-section has been developed on the basis of IRC-73: 2015. 7 / 7.5 m carriageway having lane width of 3.5m has been provided. The hard shoulder width of 0.9 m on both sides is provided. The earthen shoulder of 1m on valley side has been provided at locations where normal embankments slope are provided. Drain has been provided on hill side and parapet wall/ W- beam crash barrier are provided on valley side along with retaining wall.

0.9.3 Horizontal Alignment

The horizontal alignment of the corridor has been designed for a speed of maximum 60 kmph and minimum of 30kmph except at hair pin bends where design speed is 20kmph. The corridor is fixed based on existing alignment, by minimum disturbance to habitation and efforts have been made, during design of horizontal alignment to keep it as fluent (higher radius) as possible.

0.9.4 Vertical Alignment / Gradient

The Vertical Alignment has been designed for minimum criterion of Stopping Sight distance as specified in IRC: SP 23. The existing ground profile shall be reviewed on the basis of profile, cross sections taken at regular intervals with the aid of triangulated Digital Terrain Model (DTM).

0.10 Structure Proposals

Structures have been provided at river/ nalla/ pond/ tank/ stream/ canal crossings. These are Major Bridges (MJB), Minor bridges (MNB), Box culverts. The structure proposals for the Project Highway are given in table below;

Table 0-9: List of Proposed Structures

Sl. No.	Type of structures	Numbers
1	Minor Bridges	2
2	Culverts	124

Details of Structure proposals are elaborated in the chapter under Improvement Proposals and Design.

0.10.1 Protection Works

In mountainous and steep terrain, the geometric of the road shall be such that it gives the optimized and safe solution. The protection work plays the vital role in such terrains. The Hill side of the road shall be provided with drain and breast wall upto 3m height. Above that cutting with a slope of 1 Horizontal to 4 verticals is provided upto 6m of height with benching of 1 m and consequently the slope of 1 horizontal to 4 verticals with benching is provided till it reaches the ground. On valley side retaining wall shall be provided with safety barrier in the form of parapet wall/ W- beam crash barrier.

0.10.2 Hydrological study

For performing the hydrological and hydraulic analysis which essentially need the design flood of a specific return period for fixing the waterway vis-à-vis the design HFL of bridges depending upon their size and importance to ensure safety as well as economy. As per IRC: SP: 13-2004 & IRC: 5-2015-Section I General Features of Design specify that the waterway of a bridge is to be designed for a maximum flood of 100 years return period. The catchment area shall be marked on the topo sheets of Survey of India or satellite imageries for their assessment.

The following methods can be used to estimate the peak discharge for bridge sites on minor streams;

- Dicken's Formula
- Rational Method
- Ryves Formula

Highest of above shall be considered as design discharge. With the design discharge, calculations for the 100-year flood level shall be obtained using manning's equation based on the 100-year flood discharge. Afflux calculation, span arrangement and scour levels for piers and abutment shall be estimated.

Road side drains are necessary on a hill road. Trapezoidal section of side drain shall be taken up as specified IRC: SP: 48-1998.

0.10.3 River Training & Floor Protection Works

The proposed protective measures are to be provided in accordance with the requirement of IRC: SP: 48-1998 for culverts and minor bridge (If required). Downstream floor stepped

pitching (one or series of toe wall) meeting to ground slope profile shall be provided as energy dissipators. In upstream side, flow from the hill road drains shall be collected in catch pit for smooth movement of flow towards downstream side of valley.

0.11 Pavement Design

Flexible pavement with granular base and sub-base has been proposed for widening/re-alignment and new construction of main carriageway, proposed bypass and junctions.

The design of Flexible pavement for widening of main carriageway, Junctions and proposed bypass sections have been carried out in accordance with IRC: 37-2012. Following parameters are considered in pavement design.

- Design life of 15 years has been considered
- 10MSA is considerd for the pavement design.
- Effective design CBR of 8% is considered in pavment design.

Recommended Pavement Design for project highway is given in table below;

Table 0-10 Proposed Flexible pavement design for Reconstruction, New Construction and Widening

Design Chainage (km)		Design Traffic (MSA)	CBR (%)	Proposed Flexible Pavement Thickness (mm)				Total (mm)
From	To			BC	DBM	WMM	GSB	
29.600	51.500	10	8	40	50	250	200	540

VG-40 Grade of bitumen shall be adopted for BC and DBM layer

0.11.1 Strengthening of Existing Pavement

The entire project road is recommended for reconstruction from Sub-base layer onwards due to poor and very poor condition of existing raods and insufficient crust layers.

0.12 Cost Estimate

The unit rates for each construction items have been arrived by using the "Nagaland Schedule of Rates (SOR): 2016-17 and escalated from WPI'' in this report. The detailed analysis has been carried out as per Standard Data Book of Ministry of Road Transport & Highways (MORT&H) for deriving unit rates of items of Road and Bridge works.

The input rates of Cement have been taken from market. Input for Emulsion has been taken from IOCL, Inputs for steel has been taken from SAIL, the rates of plant, machinery, labour and other materials like metal, sand Earth etc. have been taken from Nagaland SOR 2016-17. The basic rates for each construction items have been analysed on the basis of Schedule of Rates, the prices of construction materials collected from various sources and on the anticipated distance between source and the site of work. For items where rates are

not available in SOR, the rates have been adopted as per previous experience of the consultant or on the present market rates

The detailed cost estimate is given in a separate volume. The summary of project cost has been worked and given in table below;

Table 0-11: Abstract of Cost Estimate

Sr. No.	Particulars	Amount (INR)
1	Site clearance and Dismantling	36,42,925
2	Earth Work	28,41,17,000
3	Granular Sub Base Courses and Base Courses (Non- Bituminous)	39,84,11,667
4	Bituminous Pavement Courses	20,97,28,397
5	Culverts	12,98,78,979
6	Bridges	
	a) Minor Bridges	0
	b) Major Bridges	0
	c) FO, ROB	0
	d) VUP/PUP	0
	c) Repair and Rehabilitation of bridges and culverts	16,84,688
7	Drainage & Protective Works	99,88,69,302
8	Junctions	1,28,53,094
9	Traffic signs, Road markings and other road appurtunences	11,26,31,674
10	Miscellaneous Works including truck lay bye and bus lay bye	2,56,41,620
11	Maintenance of Existing roads during Construction	1,38,27,946
A	**Civil Cost**	**2,19,12,87,293**
B-1	Contingency Charges 2.8% @ Civil Cost	**6,13,56,044**
B-2	Add GST 6.0 % @ Civil Cost	**13,14,77,238**
C	**Sub Total (A+B1+B2)**	**2,38,41,20,575**
D	Supervision Charges 3% @ Civil Cost	**7,15,23,617**
E	Agency Charges @ 3% on C	**7,15,23,617**
F	**Sub Total (C+D+E)**	**2,52,71,67,810**
G	Maintance Cost @ 2.5% on Civil Cost for 5 Years (1st & 2nd year 0.25%, 3rd & 4th year 0.5%, & 5th year 1%)	**5,47,82,182**
H	Escalation @ 5% per annum for 2 years on A	**21,91,28,729**
K	**Total Project Cost (G+H)**	**2,80,10,78,721**
	Cost Per Km in Crores (On Civil Cost)	**10.84**
	Cost Per Km in Crores (On TPC)	**12.73**
	Utility Shifting @0.5%	**1,09,56,436**
	Land Acquisition, Resettlement and Rehabilitation Cost	**61,12,09,426**
	Environmental Cost	**1,24,74,229**
	Total Capital Cost	**3,43,57,18,813**

0.13 Conclussion and Recommendation

As per the traffic requirements the Project Highway requires capacity augmentation from Single Lane to Intermediate Lane in the year 2041-42 and from Intermediate Lane to Two Lane much after year 2052-53 with respect to the highest traffic volume at km 64.500 near Pfutsero.Therefore, the traffic projections on the project highway do not demand for the 2-laning with paved shoulders in near future.

The project highway is recommended for minimum of 7m wide two-lane carriageway with 0.9m hard shoulder. One metre earthen shoulder is provided on valley side.